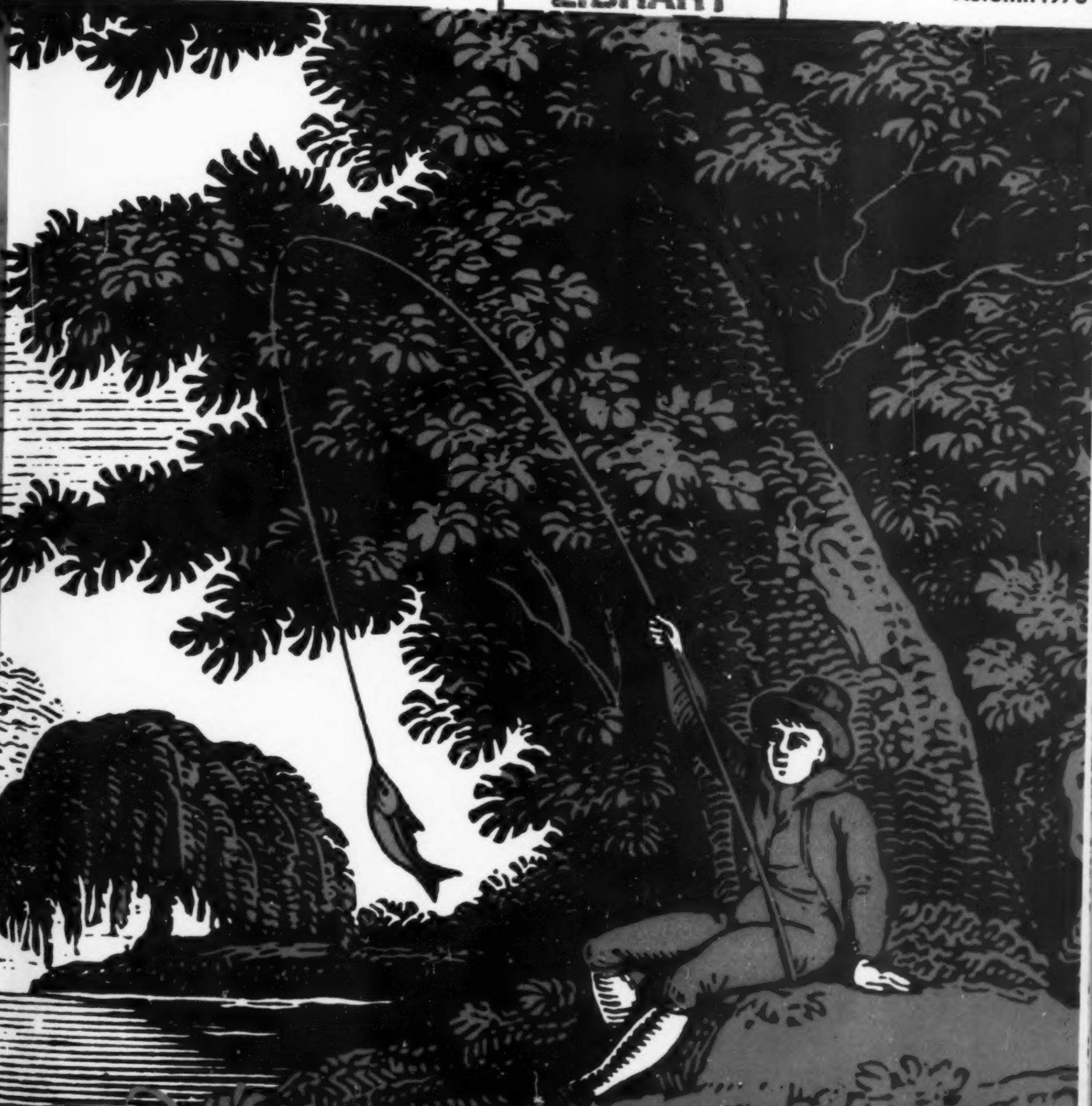
U.S. Bureau Per Rm

ECLAMATION

era

A Water Review Quarterly

Autumn 1973



Autumn 1973 Vol. 59, No. 4

RECLAMATION era

Kathleen Wood Loveless, Editor

Contents

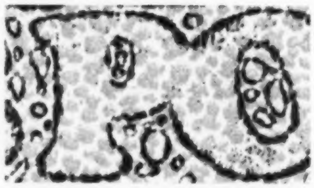
United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation,
Gilbert G. Stamm, Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director, Office of Management and Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 75 cents (single copy). Subscription price: $2.50 per year (75 cents additional for foreign mailing.)


1


3

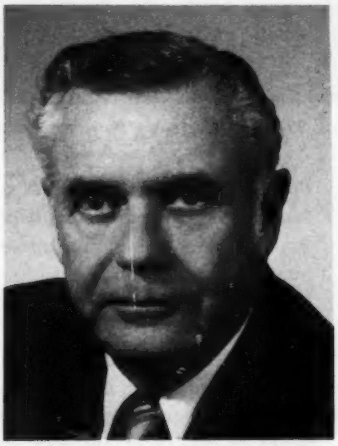

11


15


18


21

INTRODUCING



Gilbert G. Stamm

Gilbert G. Stamm, appointed Commissioner of Reclamation on May 16, 1973, is a man with 27 years' experience in water resources development and management who has been recognized for his accomplishments in the field. The Department of the Interior Distinguished Service Award and the Colorado State University Honor Alumnus Achievement Award exemplify the recognition he has received.

A native of Colorado and a 1935 graduate of Colorado State University, Commissioner Stamm has served in the Federal Government since 1936. Ten years later, he began his career with the Bureau of Reclamation in the Regional Office at Boise, Idaho.

He held positions there of Assistant Regional Supervisor of Operation and Maintenance; Superintendent, Central Snake project; Regional Supervisor of Irrigation; and Assistant Regional Director for the Pacific Northwest Region. In 1959 Mr. Stamm transferred to Washington, D.C. as Chief, Division of Irrigation and Land Use, and from 1964 until his recent appointment he served as Assistant Commissioner.

Secretary of the Department of the Interior Rogers C. B. Morton explained, "Having a man of Mr. Stamm's extensive background and experience as head of the Bureau of Reclamation will open new dimensions for the Interior Department's programs of water resource development and management in the 17 contiguous Western States."

Mr. Morton continued, "I look forward to working with Mr. Stamm and to his strong leadership in this vital function of the Department to improve the quality of life in that area of the country where the water is scarce and the most valuable natural resource."

When asked to reflect upon his new position, the Commissioner had the following reaction:

"I have a deep and abiding dedication not only to what the water resource development program has done, but also to what it can do for the benefit of future generations. I believe any long-range resource development program, to be successful, must be dynamic.

Commissioner Gilbert G. Stamm took his oath of office on May 29, 1973. Secretary Morton administered the oath while Mrs. Stamm held the Bible.

Policies and procedures must continually be reviewed and updated to keep abreast of national and project goals. Likewise, periodic updating of legislative authority is fundamental.

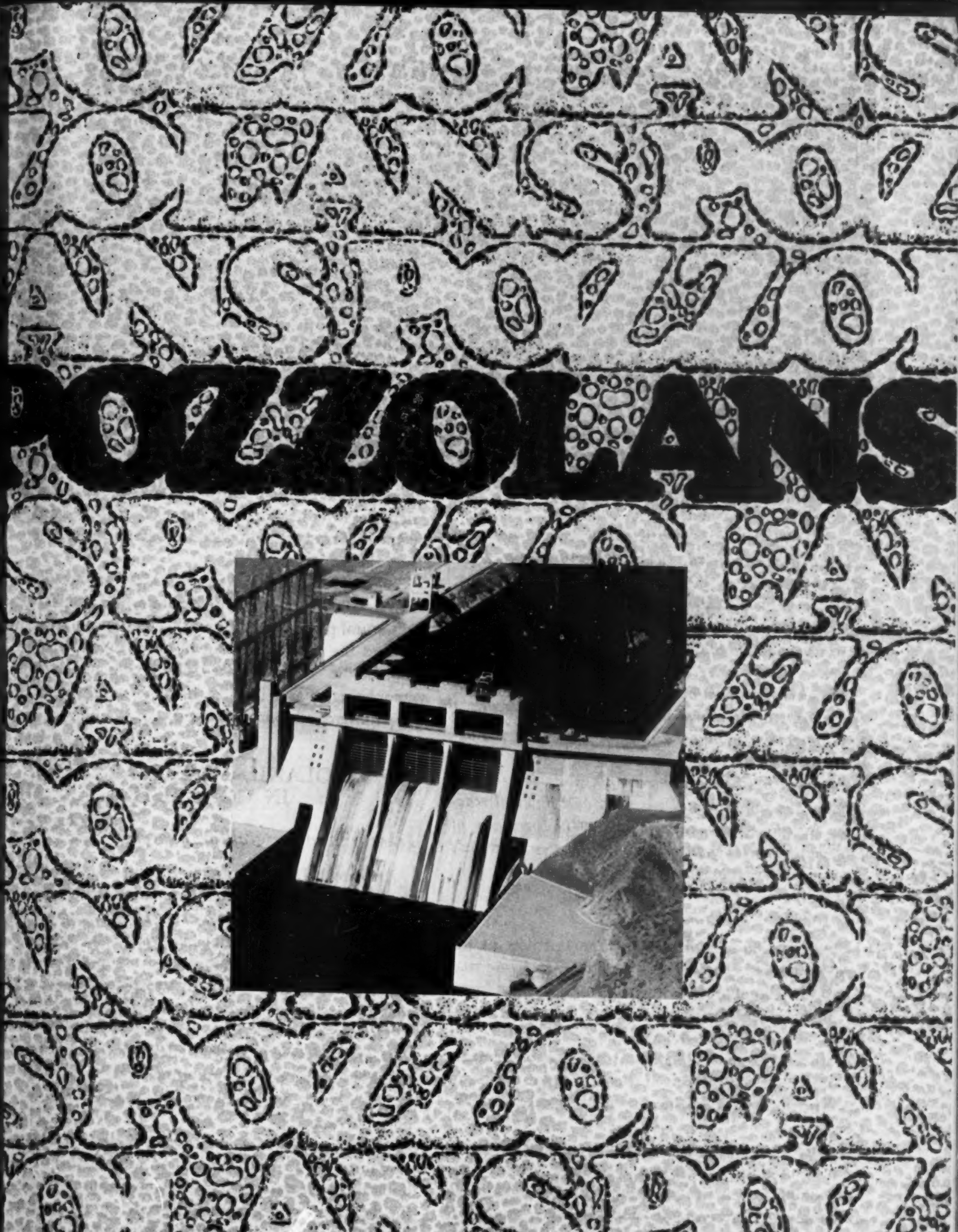
"For example, in the mid-twenties and again in 1939 Reclamation's basic legislative authorities were updated. Although additional landmark legislation has been enacted in the interim, it is again time to review and update legislative authority to reflect changing emphasis on economic, environmental, and social values. This new emphasis is not revolutionary, rather evolutionary."

"The Bureau of Reclamation," he continued, "has a unique ability to meet the challenges of society's evolutionary philosophy and demands because it has staff expertise that is second to none in competence and versatility.

"Let's consider further the $6 billion-backlog issue. There are five alternatives to the problem of getting the backlog to a manageable level. First, cancelling some projects; second, deferring others; third, staging construction; fourth, reforming the financial program to allow more funds to be spent on the backlog; and fifth, combining two or more of the above alternatives.

"For us to reduce the backlog and maintain our present projects will require accurate planning and cooperation from Congress.

"As Commissioner of Reclamation, I have considered these issues and will support those solutions which will most benefit our Nation." □


POZZOLANS

By RALPH J. ELFERT, Jr., *Retired Civil Engineer, E&R Center, Denver, Colo.*

Editor's Note: Those of you who are new to Reclamation may be wondering what on earth a pozzolan is. More accurately, you may be wondering what in *earth a pozzolan is. Pozzolans, either natural or artificial, are materials with cementing and other beneficial properties and are widely used to supplement manufactured cement where large quantities are required.*

Pozzolans get their name from the natural cement obtained near Pozzuoli, Italy, which has been used since the time of the ancient Romans. That cement is a volcanic ash from inside the earth—specifically, from Mount Vesuvius.

Other natural cements are volcanic tuffs, pumice, and diatomaceous earth. Artificial pozzolans include fly ash, granulated blast furnace slag, and burnt clay or shale.

They are beneficial because they reduce the amount of manufactured cement needed in concrete construction. Pozzolans are also effective in preventing the deterioration of concrete in the presence of alkalies.

Research has been conducted for many years to determine the fundamental chemical and physical reactions in the setting of cement in the presence of pozzolans. The following is a discussion of the Bureau's experiences with pozzolans.

Since the Bureau of Reclamation operates in the western United States where natural pozzolanic materials are abundant in large deposits in various forms of pumice, volcanic ash, tuffs, clays, and shales, economic availability has dictated the use of several types of natural pozzolans. Until about 5 years ago, the nearest sources of fly ash (an artificial pozzolan) were in the Midwest around Chicago, Kansas City, and St. Louis.

In spite of the locational disadvantage of fly ash, we have used large quantities of it in our concrete. We are looking forward to production of good quality fly ash from large, recently-developed western sources in the "Four Corners area" (joining Colorado, Arizona, New Mexico, and Utah) at the Mohave Station in Nevada, and the plant under construction at Page, Ariz.

Different Pozzolans

Our use of pozzolan has not been limited to fly ash. Table 1 lists the different types of pozzolans and the various structures in which these materials have been used. Our experiences with pozzolan in concrete date from 1911 and 1916 when cement for Arrowrock, Lahontan, and Elephant Butte Dams was prepared at the damsites by intergrinding about 55 percent portland cement clinker with 45 percent material from foundation excavation.

Since 1940, we have used 270,000 tons of fly ash in 7,100,000 cubic yards of concrete, and 350,000 tons of natural pozzolans in 9,250,000 cubic yards. This constitutes the use of pozzolan in approximately 50 percent of the concrete placed during this period. After completing Shasta Dam in 1945 we used pozzolan in two-thirds of all concrete placed.

POZZOLANIC MATERIALS USED IN CONCRETE

Interground Crystalline Material

Arrowrock Dam, Figure 1, is representative of the three early dams containing foundation material interground with portland cement clinker. By present standards this siliceous material had very little pozzolanic activity, although laboratory tests made at the time showed more contribution to strength than we now consider possible at ordinary fineness.

The comparatively high strengths revealed in those tests are believed to be the effect of the fineness of the interground cement, resulting from such grinding as necessary to reduce all excavation material to suitable fineness.

The combination of low cement content and severe climate at Arrowrock Dam caused considerable weathering of the surface concrete which required refacing the downstream face in 1937. Despite surface weathering, the interior concrete has given nearly 60 years

Figure 1. Arrowrock Dam 1911–15.

TABLE 1

Name	*Date completed*	*Type of pozzolan*
Arrowrock Dam	1915	Granite.*
Lahontan Dam	1915	Siliceous silt.*
Elephant Butte Dam	1916	Sandstone.*
Friant Dam	1942	Pumicite.
Hoover Dam (repair of tunnel spillway)	1942	Fly ash.
Altus Dam	1945	Pumicite.
Davis Dam	1950	Calcined opaline shale.
Hungry Horse Dam	1953	Fly ash.
Glenn Anne Dam	1953	Calcined oil-impregnated diatomaceous shale.
Cachuma Dam	1953	Calcined oil-impregnated diatomaceous shale.
Trenton Dam	1953	Portland-pozzolan cement (calcined quartzose silt pozzolan).
Canyon Ferry Dam	1954	Fly ash.
Tecolote Tunnel	1957	Calcined oil-impregnated diatomaceous shale.
Monticello Dam	1957	Calcined diatomaceous clay.
Palisades Dam	1958	Fly ash.
Twitchell Dam	1958	Calcined diatomaceous clay.
Flaming Gorge Dam	1963	Calcined montmorillonite shale.
Glen Canyon Dam	1964	Pumice.
Yellowtail Dam	1966	Fly ash.
San Luis Drain—Central Valley project (three separate contracts).	1971	Fly ash.
Initial construction for Pueblo Dam	1972	Fly ash.
Grand Coulee Third Powerplant and Forebay Dam.	1974 (est)	Fly ash.
Pueblo Dam	1975 (est)	Fly ash.
Miscellaneous small pipe contracts (use of pozzolan requested by pipe manufacturer).	During past 20 years.	Fly ash and other pozzolans.

* By present standards these materials have very little pozzolanic activity.

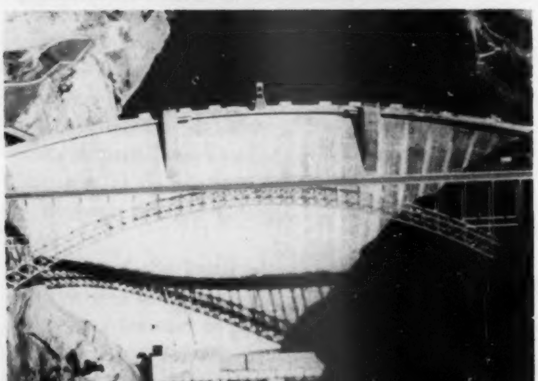
of service without structural distress. The galleries are comparatively dry and there is very little leakage through this dam. The use of the "sand-cement" was influenced by the cost of portland cement delivered to the damsite. It was prepared at a cost of $1.63 per barrel, compared to $2.36 for portland cement.

Volcanic Glasses

Representative of pumice-pozzolan concrete construction are Friant Dam, Figure 2, and Glen Canyon Dam, Figure 3. The material for Friant Dam was a fine-grained, unconsolidated pumicite excavated from the reservoir area, known as volcanic glass. It was fairly dry and of such natural fineness that no grinding or drying was required. At Glen Canyon Dam the loosely consolidated pumice was usually wet, so grinding and drying were required.

Both materials were typical of this type of pozzolan, producing about two-thirds the compressive strength of an equal weight of portland cement. The favorable price of the pozzolans resulted in considerable savings

Figure 2. Friant Dam 1940–42.
Figure 3. Glen Canyon Dam 1957–64.



in the cost of cementing materials for both jobs. Moderately beneficial effects were realized with respe to temperature rise, permeability, and reduction reactive expansion. The drying shrinkage was slight increased.

Calcined Clays and Shales

Two of the eight structures containing calcine natural pozzolan, Davis and Monticello Dams, a shown in Figures 4 and 5, respectively. The calcine clays and shales are typical of these types; superior i reactive expansion and permeability, moderate in the

Figure 4. Davis Dam 1947–50.
Figure 5. Monticello Dam 1955–57.

effect on strength and temperature rise, and usually having high water requirement and drying shrinkage. For some of these pozzolans, the high water requirement and drying shrinkage were related to the amount of diatomite present. Although economy was generally the primary factor in the use of these materials, the control of reactive expansion was an important factor in four of the structures.

Fly Ash

Fly ash from sources in the Midwest has been used in nine large structures and several small pipe contracts. Representative structures are Hungry Horse Dam, Figure 6; Yellowtail Dam, Figure 7; and Grand Coulee Third Powerplant and Forebay Dam, Figure 8. Most of the 6,000,000 cubic yards of concrete in these dams do or will contain fly ash. Hungry Horse Dam (3,100,000 cubic yards) is the largest Bureau structure in which fly ash has been used. Our experiences with fly ash have been highly satisfactory. Several randomly selected graphs from our files of data illustrate why fly ash meeting current Federal Government and ASTM specifications ranks high among better quality pozzolans. They also point out its principal limitations.

TYPICAL EFFECTS ON CONCRETE

Effect on Strength

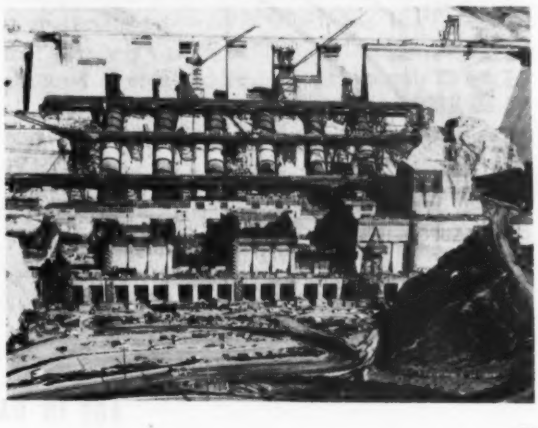
Fly ash and other pozzolans contribute to the ultimate strength of concrete. Figure 9 compares the strength development of fly ash and a natural pozzolan with the strength of the control concrete. This graph illustrates the typical relationships of lower strengths at early ages and higher strengths at later ages for fly ash concrete when compared to other pozzolans or comparable nonpozzolan concrete.

In some instances, the slower rate of strength development limits the use of fly ash in structural concrete. This objection has been overcome in some areas by replacing one bag of portland cement with one and one-half to two bags of fly ash. The rate of strength development is seldom a factor in mass concrete construction.

Effect on Heat Generation

Excessive temperature rise in mass concrete may result in the concrete cracking, hence the temperature should be controlled. Figure 10 shows the beneficial effects of a fly ash and a natural pozzolan in reducing the temperature rise of mass concrete. The rate of heat development closely parallels the rate of strength development since both are functions of the same chemi-

Figure 6. Hungry Horse Dam 1948–52.
Figure 7. Yellowtail Dam 1961–66.
Figure 8. Grand Coulee Third Powerplant and Forebay Dam 1970–74 (est.)



cal reactions. The slower rate of heat development with pozzolans beyond 28 days permits more economic removal of heat than for comparable nonpozzolan concrete.

Effect on Permeability

Pozzolans reduce the permeability of concrete by nearly 50 percent. All types of pozzolan behave in a similar manner and definitely are most beneficial in lean harsh concrete.

Effect on Volume Change

When fly ash and two natural pozzolans were tested for drying shrinkage and autogeneous length change of portland cement concrete, it was discovered that fly ash concrete performs better than other pozzolans or comparable nonpozzolan concrete.

Freezing and Thawing Durability

This is an area where special considerations are necessary to utilize pozzolans satisfactorily. The importance of moist curing on the performance of fly ash and pumice pozzolans in a severe freezing and thawing environment was illustrated during the cycles of freezing and thawing. Fortunately, not many areas of the United States have a climate as severe as that of the freeze-thaw test. In many instances, proper use of curing compounds retains curing moisture longer than is economical to supply moisture externally. The result is that satisfactory durability is attained for small structures. In other cases, reducing the percentage of pozzolan may achieve the desired durability. In mass concrete, satisfactory durability for the entire mass can be attained quite economically by using a thin face of concrete with a lower water-cement ratio and lower pozzolan content.

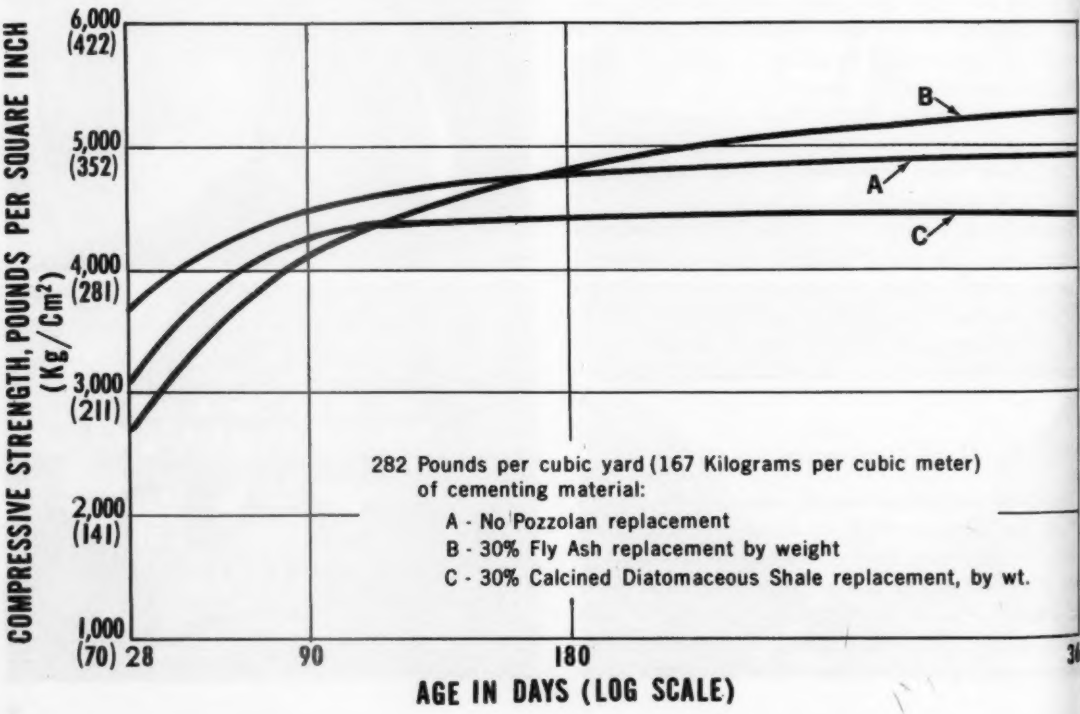
Effect of Pozzolans on Reactive Expansion

The use of low alkali cement and the use of pozzolans are the most effective means of controlling the potentially disruptive expansion which results from the reaction between certain types of mineral aggregates (cherts, opal, etc.) and the alkalies in cement. Although low alkali cement is quite satisfactory for use with most reactive aggregates, some aggregates require the additional control provided by pozzolans.

Effect of Pozzolan on Sulfate Resistance

Deterioration of concrete by sulfate attacks is a serious problem. This usually occurs when high concentrations of sulfates in soils and water are in contact with the concrete. Control of the expansive reaction

Figure 9. Effect of Pozzolan on Compressive Strength of Concrete.



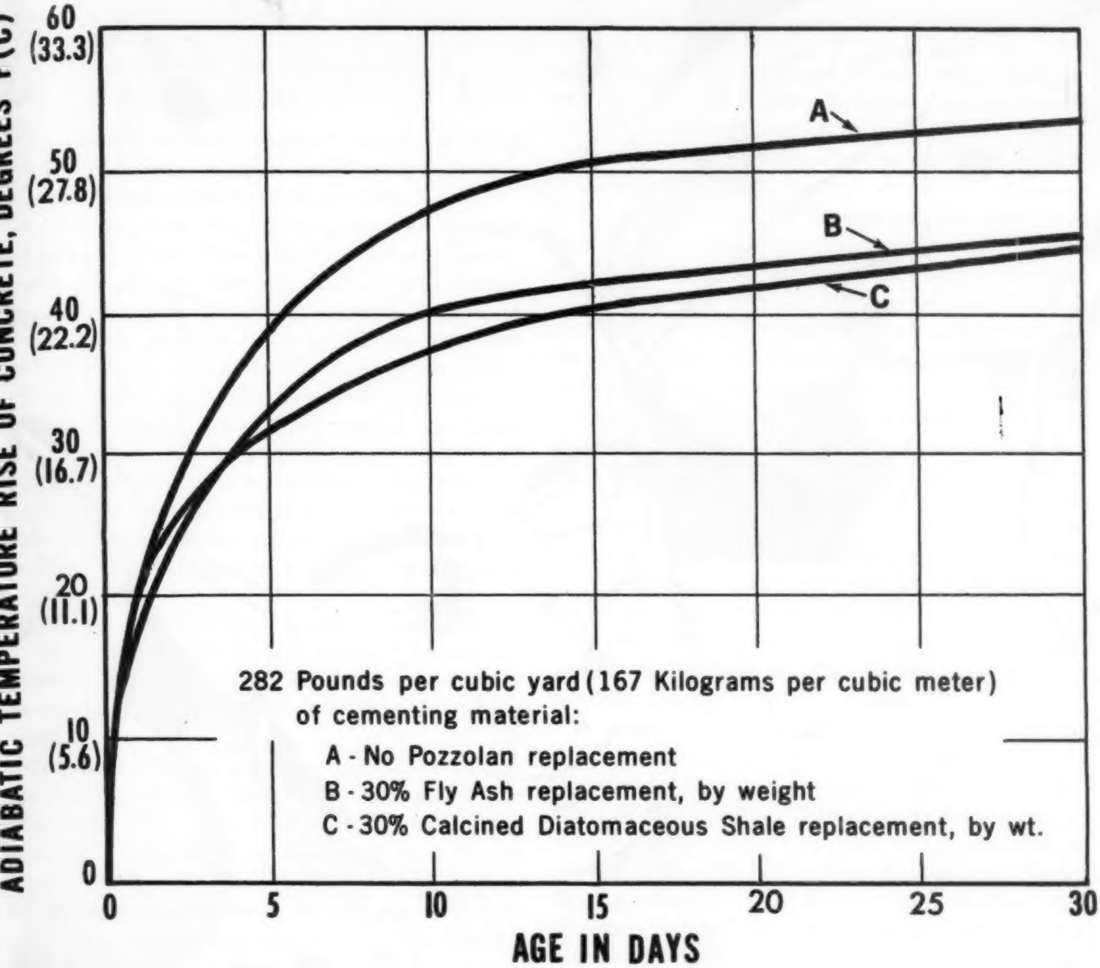


Figure 10. Effect of Pozzolan on Temperature Rise on Concrete.

which cause disruption of the concrete can be affected by reducing the amounts of the principal reactants.

Many claims have been made for the beneficial effect of pozzolans on the sulfate resistance of concrete. As early as 1908, it was reported that among the methods recognized by different authorities for combating sulfate attack was the use of a pozzolan combined with the free lime which otherwise would be leached out. A Bureau of Reclamation program of research extending more than 20 years clarified many of the claims made for pozzolan's contribution to sulfate resistance.

The Future of Fly Ash

Most people are more interested in fly ash's future than in its past. We are aware of the increasing problems that pozzolan manufacturers have in balancing supply and demand in view of the vast new sources of fly ash being developed. The Bureau of Reclamation is prepared to use fly ash of the same high quality as that used in the past in more of its concrete in the future. As always, it must be competitive with other good quality pozzolans and portland cement. The magnitude of marketing problems is reflected in the knowledge that after only 4 years' production the three large western sources recently developed could supply fly ash for all of the concrete placed by the Bureau of Reclamation since the Reclamation Service was established in 1902.

Many of the vast new fuel sources being developed are either lignite or subbituminous coal whose fly ashes differ in some respects from the bituminous coal fly ashes on which most specifications were based. The fullest possible utilization in concrete of fly ashes from these new sources of fuel will depend in large measure on the development of specifications governing their use. □

By S
Thi

"I
and
the s

It
in th
beca
doct
by t
fund

Lo
the s
man
pital
open
twice
ties.
to Sp

Be
the s
Com
and
reme

Af
Dam
incon
the o
acqu
to loo
a foc
would
time,
long s

Lo
cerne
the l
for o

By SAMUEL S. REY, Administrative Officer, Third Powerplant Construction Office

"Happiness is an open hospital," so the sign reads, and for the residents of the Grand Coulee Dam area the slogan expressed their feelings perfectly.

It all began when the privately operated hospital in the Grand Coulee Dam area was about to be closed because of financial difficulties arising from a loss of doctors in the area. Numerous attempts were made by the private operator to locate doctors and raise funds, but it was to no avail. The hospital was closed.

Local citizens were well aware of the seriousness of the situation. During the time the hospital was closed many people experienced long ambulance rides to hospitals in Spokane, Wash., and to other areas. The only open hospital facilities were over 50 miles away, and twice that distance to any sophisticated medical facilities. More critical patients were air-lifted by helicopter to Spokane.

Before the hospital closed, a public meeting under the sponsorship of the Grand Coulee Chamber of Commerce, was held for all interested organizations and individuals to discuss the situation and to seek a remedy.

After several public meetings, the Grand Coulee Dam Area Health Care Association (GCDAHCA) was incorporated with a board of directors representing the overall community. Its goals were to work toward acquiring the hospital land, building, and equipment; to locate doctors to practice in the area; and to become a focal point for a comprehensive health facility that would be community-oriented and supported. By this time, several weeks had elapsed and the hospital had long since closed its doors.

Local citizens were not the only ones who were concerned with the hazards resulting from the closing of the hospital. A serious problem was also created for over 1500 construction personnel working for contractors on the Third Powerplant and Forebay Dam, as well as nearly 500 Bureau of Reclamation employees engaged in construction and operation programs.

Because of the high-hazard activities involved, the construction contract required an on-site infirmary staffed by nurses to handle first-aid situations. The hospital was necessary as an adequate medical facility for those more severely injured. As a matter of contract administration, and certainly from the practical and humane viewpoint, the closing of the hospital rendered the on-site infirmary inadequate for medical service on a major Bureau construction program.

Throughout the intensive review of the situation, it was determined that one alternative would be to expand the on-site infirmary and to employ a full-time doctor. This solution would provide the medical requirements of the prime contract, but would offer such service to only federal and contractor workers and not to their families or the public-at-large. This alternative would also have a deleterious effect on community efforts since it would compete with them for physicians and it would divert hospital income for industrial accident treatment.

A second alternative was to reopen the hospital through either direct contract action with the construction contractor, or through a direct community effort. It was recognized that the only effective way to raise funds to open and operate the hospital and to serve all area citizens, as well as both current and future Bureau programs, was to involve the community. This approach, which was finally selected, left only the imposing questions of how to do it and how to raise sufficient funds.

The newly formed Hospital Association decided that about $250,000 would be required to acquire, staff, and operate the hospital over a period of about one year, at which point the hospital should be self-supporting. Cost analysis showed that the $250,000 would

A True Community Hospital

have to be more than doubled to achieve the same results through the Third Powerplant prime contract, but that the hospital operation would be more assured during the 3 to 4 years remaining under that contract.

Even Senators and Congressmen from the State supported the reopening effort. They received a local delegation in Washington, D.C. and participated with the group in achieving reopening.

Recognizing that both program needs and a moral obligation to a community existed principally because of previous and future Federal development, the Bureau of Reclamation offered the Hospital Association a program which would provide financing to cover hospital deficits of nearly $265,000. However, all agreed that significant community input was absolutely vital. To accomplish this end, it was agreed that the Hospital Associauon, via a local fund campaign, would acquire the hospital equipment valued at $85,000. Since the financial ability of the area would largely rely on comparatively small contributions by salaried workers and wage earners, it was anticipated that most of the area population would have to share in the effort.

All kinds of slogans and designs were used to decorate the donation jugs. R. K. Seely and H. L. Fink, the judges, had difficulty selecting the best "poster jug."

Senator W. G. Magnuson enjoyed the children during his visit and tour of the area and Coulee Community Hospital.

This decision was absolutely correct as the community, with a spirit of almost unanimous purpose and complete enthusiasm, set out to raise money under a campaign sponsored by the GCDAHCA. Money was raised from projects and groups of all kinds. From Senior Citizens all the way down through the very young school children, all 10,000 community members were helpful.

For example, a contest was held in the grade school for youngsters to design posters to be used with money donation jars in businesses. The Third Powerplant construction engineer and the operations manager judged this event, and needless to say, it was a tough decision to select the winners. Each child had his own idea of what the hospital meant to him, his family, and his community. Their fresh, unbiased, and sometimes gruesomely honest observations told the community a graphic story that many adults might not otherwise have perceived.

Other school children held a cupcake sale where they made $140, while others had car washes, dances, and many of them donated their time gathering mechandise for a highly successful auction sponsored by the Rotarians. The Senior Citizens held a profitable bake sale and luncheon. Every service club, local organization, and church group in the area did its share in raising and donating funds for the hospital. Businesses donated gifts for a raffle that resulted in a very good return.

Rev. Ronald Hunter signs the Agreement for Reopening Hospital and Furnishing Hospital Services. Lookers on are Robert A. Castrodale, GCDAHCA board member; Robert Ludolph, commissioner for Grant County; John Colby, administrator for St. Luke's Memorial Hospital; Joyce Moore, board member; Archie W. Price, board member; Mel Piatote, board member; and Irving L. Seekins, board member.

Howard L. Fink, Third Powerplant construction engineer, presents the Bureau's check to Margaret Hanson, treasurer of GCDAHCA. Rev. Ronald Hunter, president GCDAHCA, and Roger Zumwalt, administrator of Coulee Community Hospital observe with pleasure.

While all this was going on, the GCDAHCA conducted a door-to-door campaign for cash donations and pledges, covering a radius of approximately 50 miles. This campaign required much coordination and cooperation because they had only two weeks to raise the required $85,000.

The efforts of local Bureau offices, contractors, and the volunteers of the GCDAHCA helped, but it was only with the willing and understanding cooperation of individuals and families that this almost impossible goal was accomplished. Cash, pledges, and loans did secure the $85,000 and the wheels of progress began to turn.

On April 5, 1973, the contract was signed formalizing the Reclamation pledge for $265,000, and the delivery of an initial payment of $82,500 followed on May 4, 1973. This was bolstered by a donation of $10,000 by Vinnell-Dravo-Lockheed-Mannix, prime contractor on the Third Powerplant and Forebay Dam.

Finally, all efforts were rewarded by the Coulee Community Hospital opening on May 7, 1973. After being closed for 7 months, she finally opened her doors to residents and workers of the Grand Coulee Dam area.

It was most fitting that the very first patient was Mrs. Barbara Freidlander, Elmer City, Washington, who gave birth to a lovely 5 pound 6 oz. girl, Michelle Laverne Freidlander, born May 8, 1973, at 5:15 a.m. She is a living symbol of a fresh new start for the community, not only with the Coulee Community Hospital, but with the cooperation that developed among a diverse four-town, four-county area.

Perhaps this is best summarized by Congressman Mike McCormack's thought expressed in a newsletter to his constituents where he characterized this story under the heading, "To Dream the Impossible." □

conservation education in california

By GERALD E. KING, Community Affairs Officer, Mid-Pacific Region

A short while ago the Mid-Pacific Regional Management Team decided to expand the Region's program of conservation education in the California school systems.

The program has existed informally for the past 6 or 7 years and has operated on a more formalized basis since the 1971 publication of a curriculum guide entitled, *Conserving California Resources.*

The need for conservation education has been recognized by the California Legislature and by anyone who has ever had to explain that the Bureau of Reclamation is not in the business of reclaiming tin cans, nor is it a branch of the California State Department of Water Resources.

The reasons behind the need to teach our children about the relationship among land, water, and people are many, but for the most part they boil down to the migration from farms to cities over the past three decades and the accompanying changes in our society.

While it once was common for a child to learn of life around him in the fields and in the family's chicken yard, now he may grow up believing that cows are kept in zoos and milk is made in factories.

An adult whose only association with irrigation is sprinkling a window plant can hardly be expected to understand the significance of dams, pumping plants, canals, and water distribution systems. Not only can he not be expected to understand their significance, he cannot reasonably be expected to make well-informed decisions about the development of such projects—and, hence, about the future of the Bureau of Reclamation.

Future Voters

The Mid-Pacific Region educational program is designed to give the future voting citizen as much basic information as possible about water resource management, so at some future date he may be sufficiently well-informed to make decisions based on his own knowledge of the subject. To the extent possible, the regional educational program avoids philosophical arguments. Rather, it seeks to teach the basics of water resources management as carried out by the Bureau of Reclamation and similar organizations, such as the Corps of Engineers and the California State Department of Water Resources.

The regional conservation program began to escalate about 6 years ago when a decision was made to be as generous as possible when furnishing brochures and project map materials for educational purposes.

At that time, requests for information about our projects for classroom use were more or less incidental and accounted for about 6,000 copies of various brochures being mailed in a year's time. The word about our cooperation has spread. Teachers and students now request our material at the rate of about 250,000 copies a year.

Early in the program it was realized that, while our materials were quite well accepted and the "market" was growing, most teachers who wanted information from us were operating pretty much in the dark. They had no real idea what to expect from us and no real

notion of how to use it once it arrived in the classroom. In addition, most teachers were in the same position as so many other people in California. They had no basic knowledge of the Bureau of Reclamation, its functions, its past achievements, or its capabilities.

Robert Kaufman

About the same time, we became aware of Robert Kaufman, a teacher at South Lake Tahoe. Kaufman was a former employee of the Bureau of Reclamation and had used the Bureau as a subject for teaching his students about environment.

Kaufman requested Bureau materials and speakers and similar help from other organizations. His approach worked extraordinarily well. Not only were his fourth graders completely taken by the subject, they could discuss it reasonably well and on occasion even put visiting speakers on the spot. Kaufman had devised a way to organize the information available to him from water-oriented organizations. By making use of this material and the basics he had learned while working with the Bureau, he was able to offer to his students an educational experience on basic water resources management of the highest quality.

Kaufman was working toward a Master's Degree in Education and decided to see if his successes could be transferred into curriculum unit form—that is, put on paper—and developed into a widely useful educational program. A research and development grant was arranged and Kaufman set to work at San Francisco State College, under the auspices of the School of Education and the Frederick Burk Foundation for Education.

Conserving California Resources

As it turned out, the project was more than Kaufman could handle as part of his Master's program. He managed to compile a unique bibliography of free and inexpensive materials on water resources management available to teachers. Also, while at school, he drafted the remainder of the curriculum unit document. However, it was 2 more years, after Kaufman went back to his fourth graders at South Lake Tahoe, before the book now known as *Conserving California Resources* was finally published and distributed for testing in the schools.

Conserving California Resources is now the keystone of the regional conservation educational program. It is divided into three parts: the first deals with the background information necessary to a teacher in elementary water resources management, the second section teaches a series of basic concepts, and the third is a unique bibliography developed by Kaufman. The book is in the hands of about 350 teachers in California and the list grows daily.

The California State Capitol in Sacramento, has greatly benefited from water and power supplied by projects built and operated by the Bureau of Reclamation.

California needs a conservation educational program so children like these may better understand the relationship among land, water, and people.

The book is free to any teacher who wishes to use it. It has been described by some teachers as the best single environmental educational document available in California today. A large part of the success of *Conserving California Resources* is directly attributable to the backup it receives in the form of brochures, project maps, fact sheets, and other Bureau publications; speakers on various subjects (principally the Central Valley project); and developments now in the public eye, such as the Auburn-Folsom South Unit and the Peripheral Canal; slide shows; Bureau and other agency movies; and a recently inaugurated program of project tours.

Spread the Word

Bureau employees can be a great help in spreading the word about educational services available in each region. If you are a member of an educational-oriented organization, such as the PTA, or if you have contact in some other fashion with teachers, feel free to offer Bureau materials. Although each region does not have an educational program as developed as the Mid-Pacific's program, all regions are happy to offer assistance and Bureau materials to educators and other individuals.

Sample copies of *Conserving California Resources* and teacher packets of supporting material are readily available from the Regional Information Office. Visit or write Jerry King or Joyce Dedrick at: Regional Office, Department of the Interior, Bureau of Reclamation, Federal Office Building, 2800 Cottage Way, Sacramento, Ca. 95825. A telephone call from any field office will get packets of material out right away, either to the caller or the teacher.

Should you happen to find a group of interested teachers willing to sit still for an hour, presentations of the material and suggestions for use are readily arranged through most Information Offices.

In addition to serving the classroom teacher, the Bureau is willing to discuss its activities with virtually any adult group. Since PTA's are often interested in non-partisan issues, they provide an excellent opportunity for presentation of Bureau projects and discussion of its role. Do not hesitate to make the offer, even if you would rather not make the presentation yourself. Contact your region's Information Office and arrangements will be made to meet the commitment.

Contact People

In addition to providing a needed service to the public, an educational program is one of the best available means for the Bureau to establish and maintain contact with people. It will take time and effort, but it is absolutely essential if the Bureau is to assume its proper role in today's environmentally-oriented world. □

YESTERDAY IN OUR MAGAZINE

THE RECLAMATION ERA—1938

The Salton Sea in Imperial Valley

To passengers on the sunset route of the Southern Pacific Railroad through Southern California, as well as to automobile tourists traveling U.S. Highway No. 99, the immense lake known as the Salton Sea is an object of much interest. It is in the southern part of the State and in the northern end of Imperial County. It is about 45 miles north of the Mexican border and 150 miles southeast of Los Angeles. Transcontinental passengers on Southern Pacific trains follow its northeastern shoreline for about 30 miles and travelers in automobiles, a similar distance on its opposite side.

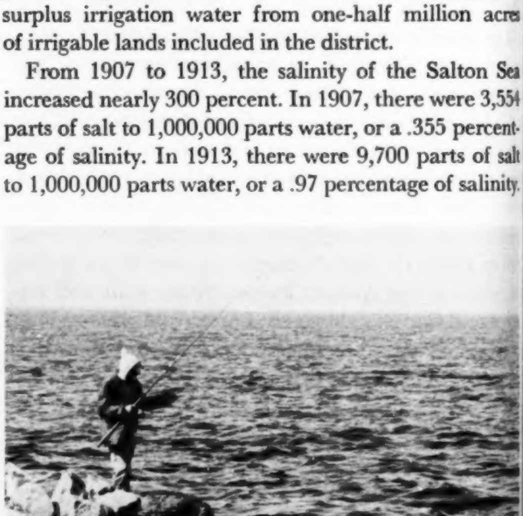
The Salton Sea came into national prominence in 1905 when the Colorado River broke its banks a short distance below the international boundary line west of Yuma and for 15 months flowed through the Alamo and New Rivers into the Sea, threatening the destruction of much valuable property, both farming and city. After arduous and expensive work, the river break was closed in February 1907. During the period of inflow from the Colorado River, the water level rose 60 feet, and the Sea attained a maximum depth of 78½ feet with a maximum elevation of 195 feet below sea level.

In January 1938, the water surface of the Sea was 246.4 feet below sea level and its maximum depth was 26½ feet. It is the lowest part of Imperial Valley with the exception of Death Valley, also in California, which is 276 feet below sea level.

In earlier times, the Salton Sea was known as Lake Cahuilla, named after the tribe of Cahuilla Indians. The Gulf of California originally extended north into what is now Imperial Valley, and the lake area occupied the northwestern part of what was once the Gulf, being that portion cut off from the Sea by Colorado River delta deposits.

The rate of evaporation, less rainfall, on the Sea is about 7 feet per year. The Sea is utilized by the Imperial Irrigation District as an outlet for drainage and surplus irrigation water from one-half million acres of irrigable lands included in the district.

From 1907 to 1913, the salinity of the Salton Sea increased nearly 300 percent. In 1907, there were 3,554 parts of salt to 1,000,000 parts water, or a .355 percentage of salinity. In 1913, there were 9,700 parts of salt to 1,000,000 parts water, or a .97 percentage of salinity.



TODAY

RECLAMATION ERA—1973

Salinity Solution Outlined

The salinity problem of the Salton Sea, indicated many years ago by the 300-percent increase between 1907 and 1913, continues to plague water users. Already saltier than the ocean, the Salton Sea is California's largest body of inland water.

After a 9-month study, Bureau officials and members of a citizens group called Project Salton Sea believe they have found a way to curtail the salinity of the Sea.

The proposed solution is a 32-mile-long dike system which would encompass a 40-square-mile area at the south end of the Sea in which water would evaporate, thus trapping the salt.

It would be an earthen dike composed of dredgings from the bottom of the sea with rocks sprinkled over it to prevent erosion, thereby creating a lake within a lake.

Under a $250,000 appropriation from Congress, the Bureau has been researching the feasibility of the system and will continue to drill for core samples to be sure bottom materials can be used for the dike.

The dike would rise 6 feet out of the water and would measure between 100 and 200 feet wide at its underwater base. Simplified, when the water enters the Salton Sea from New and Alamo Rivers, it would force saltier water into the dike area. The salt accumulated within the diked area would be confined and would not enter the main body of the Sea. The salt would be removed every 75 or 100 years.

The cost for this project was first estimated as high as $130 million, but that estimate was obtained before core studies were made. The cost is now believed to be about $57 million, but if most of the material needed can be dredged up from the bottom of the sea, a more realistic cost would be $35–$40 million.

Eight State agencies participated in the study including the California State Department of Water Resources which furnished the rig and crew to do the drilling.

The money to be used for the project is considered as a loan and would be paid back by placing a tax on fishing licenses, a $2 or $3 tax on boats, and about a 10-cent addition to the property tax on land surrounding the Sea, excluding agricultural areas—all this is a relatively small price to pay for a renewed Sea.

Water from the salty New and Alamo Rivers would flow in direction of arrows, forcing saltier water into the dike area to evaporate.

By C
Comp

If
ated
and v
of Ec
we w
The I
morn
needs
norma
streets
then
broke

The
the ci
away.
have r
Ecbata
with th
to its
the cit
now co
zation
duct a
veritab
face su
enough

Ecba
fate of
was ne
in sum
cessors
Persian
of Mac
into rui
on its si

By C. H. VIVIAN, Contributing Editor,
Compressed Air

If we could board the wondrous time machine created by Doctor Wonmug of the Alley Oop comic strip and whisk ourselves back to the ancient Assyrian city of Ecbatana on a certain day in the year 626 B.C., we would find a sad and badly frightened populace. The housewives who had gone to a nearby street that morning to get a jar or goatskin of water for the day's needs had found only a trickle where a sizable stream normally flowed. Alarmed, some had gone on to other streets and found the same conditions. The dire news then spread like wildlife: "The kanat has been broken."

The kanat was an underground conduit that brought the city's water supply from mountains a few miles away. A relatively simple repair job would normally have restored its flow, but this was no ordinary time. Ecbatana was under attack by legions of Medes who, with the Persians, had migrated from the north. Thanks to its well-fortified seven concentric protective walls, the city had resisted the assault for several weeks. But now consternation gripped the citizens with the realization that the enemy had located the buried aqueduct and put it out of commission. Deprived of that veritable lifeline, the people knew they would soon face surrender, followed by servitude if they were lucky enough to escape death.

Ecbatana was fortunately spared the not unusual fate of being destroyed by its conquerors because it was near the mountains and therefore relatively cool in summertime. Medean kings and their Persian successors made it their summer residence, but after the Persian Empire succumbed to Alexander The Great of Macedon in 330 B.C., Ecbatana was allowed to fall into ruins. The city of Habadan, Iran is now near or on its site.

The course of history in that region undoubtedly was greatly affected by the kanat. Many other communities in the perennial battleground of the Near East probably met the same, but unrecorded, fate as Ecbatana. One of man's early engineering structures, this forerunner of modern tunneling techniques still supplies much of the water for people, livestock, and crops in some parts of Asia Minor.

The spelling of kanat with a "k" is of recent adoption. The original name, kariz, still used in Afghanistan, was derived from the Assyrian or Akkadian language that was spoken in Mesopotamia from 2800 to around 100 B.C. Sometime later it became "qanat" or variations such as "qwanat" and "ghanat." In northern Africa, where the same or similar desert water-supply system was once used from the Atlas Mountains eastward, the structures were called "foggaras." It is uncertain where and when the first kanats were built. Some accounts indicate that they served the ancient Assyrian capital of Ninevah around 800 B.C. They are most often associated with Persia (now Iran) because they had their greatest development there.

Iran, a little larger than Alaska, ranges in elevation from 92 feet below sea level to 18,934 feet above. Most of its streams, fed by melting snow in springtime, flow from the peripheral mountains and dry up by midsummer when they reach the central lowland desert areas where temperatures exceed 100° F and annual rainfall is less than 5 inches. Evaporation shrinks Lake Urmia, Iran's largest, from a springtime area of 2,300 square miles to 1,500 square miles during the hot season. Although most of Iran's 30 million people depend upon agriculture for livelihood, only about 15 percent of the land is cultivated. About two-fifths of this is irrigated, mainly by kanats. The remainder, in mountain valleys at elevations from 6,000 to 8,000 feet, depends entirely upon rainfall. Crops, which vary

kanats

with altitude, include grains, cotton, sugar beets, tea, tobacco, citrus fruits, dates, nuts, and melons. Opium poppies with morphine content to 12 percent—the highest known—yield the Nation's principal painkiller, used much as Americans use aspirin.

Gentle basal slopes of the mountain ranges contain the water supply for kanats. Traditionally, the first step in construction was to sink a vertical shaft to a depth slightly below the water table, commonly 200 to 300 feet. One shaft at Gunabad reputedly reached 1,000 feet. From the bottom of the shaft, a tunnel was started toward a lower-level objective area. To minimize excavation, the cross section was barely large enough for a small man to work in a kneeling position. This obviously limited the working force at the heading to one person. Excavation was done by hand, using small picks and shovels. Spoil was loaded into goatskin bags, dragged to the shaft bottom, and hoisted to the surface with a windlass operated by two men.

Surveying knowledge and its related instruments were scarce at the time, but geometry, on which surveying is largely based, was not unknown. The Egyptians certainly used it in erecting the pyramids and also in re-establishing property lines after their almost

In underdeveloped countries children learn, first-hand, about irrigation.

annual obliteration by overflow of the Nile River. For sinking their shafts vertically, the kanat builders apparently used plumb bobs. To keep a tunnel on the prescribed line, the excavator sighted across two flares stationed some distance to his rear. Maintaining the correct tunnel grade was of vital importance. The slope had to be sufficient to ensure a steady flow of water, but not so steep as to erode the bottom, which was usually unlined. It is likely that a gnomon, shaped like a carpenter's square, was used to keep the grade uniform.

To ensure ample breathing air in the tunnel and to limit the distance spoil had to be hauled, additional shafts were sunk at intervals of perhaps 150 feet. On that basis, there would be about 700 of them for a 20-mile kanat. A vast amount of excavating was thus required, all performed without the aid of mechanical drills and explosives. From the air, mounds of earth marking the course of a kanat appear as molehills. Today, many such lines lead to a few tumbled walls of a deserted town. They tell a silent tale of a water source that dried up or of destruction of the kanat by an enemy. In either case, the residents were forced to leave. The Greek historian Herodotus, writing of

This primitive use of ground water is another form of irrigation.

summarizing the advantages of kanats in one sentence: "Water is not stolen from them, either by men or the sun."

The importance of kanats was emphasized in September 1962 when an earthquake devastated 8,000 square miles of land near the capital city of Tehran. Responding to an urgent appeal by peasants to restore the damaged kanats, Shah Mohammed Riza Pahlevi ordered army troops to form shovel brigades for making repairs. A dispatch to *The New York Times* during that period estimated the aggregate length of all active kanats in Iran at 100,000 miles.

Formerly, most kanat-irrigated land was held by absentee landlords, who also owned the villages where their tenant farmers lived. Besides land, the owners usually provided houses, seed, water, and work animals. Tenants furnished labor and implements for their share of the harvest, generally about one-fifth. When Shah Pahlevi ascended to power in 1941, more than half the arable land was in this category. He began distributing his own large land holdings to the workers and initiated legislation requiring others to do likewise. By 1962, more than 500 villages and the land tilled by their residents had been transferred from the landlords to tenants, who were permitted to pay for them over a period of 25 years.

Many Iranian towns and cities not located near streams have received their domestic water supplies

wars in Persia, mentioned the simple tactic of filling in shafts to capture a town. In view of this, it is obvious that one of the primary preparations for withstanding attack was to remove the mounds that marked the shaftheads and to cover or camouflage their entrances. In times of peace, shafts were kept open to facilitate maintenance or repair work periodically required in the tunnel.

Herodotus recorded that Iran's southwest province of Khuzistan once supported a population of 10 million by its agricultural development. Many of the farms were watered by kanats, others by canals extending from stream dams or dug wells pumped by ancient devices. One of the latter, the noria, is still known as the Persian wheel. For 7 centuries following 1200 A.D., these irrigation works gradually crumbled. Khuzistan became largely a desert and its population had shrunk by 1956 to an estimated 370,000. The Iranian government then commissioned two former chairmen of the United States' Tennessee Valley Authority, David E. Lilienthal and Gordon Clapp, to direct a 5-year study of Khuzistan's resources and recommend a development plan. As a result of this and other investigations, there has been notable construction of dams, but for a large part of the country nothing meets the climatic conditions as well as the kanat system. Najmeh Najufi, an Iranian girl, while attending Stanford University a few years ago wrote a book, *Persia Is My Heart,*

In many countries of the world crop production would be impossible without several forms of irrigation.

from kanats so long as the supply was sufficient. Teheran, the capital and largest city, relied solely on existing kanats until its population approached 300,000. Additional kanats were built as they were needed until there were 36, from 8 to 16 miles long, obtaining the water from the base of the Elburz Mountains.

When a kanat enters a town, it surfaces and divides into branches that feed water to several streets, where the streams become jubes. Since water is charged for according to the amount used, wealthier residents live upstream where the flow is greatest and contamination least. Those who can afford a garden have one, and often a pond stocked with fish. Toward sundown, the flow in each street is increased, in turn, to flush away accumulated debris. Later, the Mir-e-Ab makes his rounds, knocking on doors and telling residents to turn water into their yards. Drinking water is usually taken out where the kanat reaches the city limit and delivered throughout the community, either free or for a small charge per bucket.

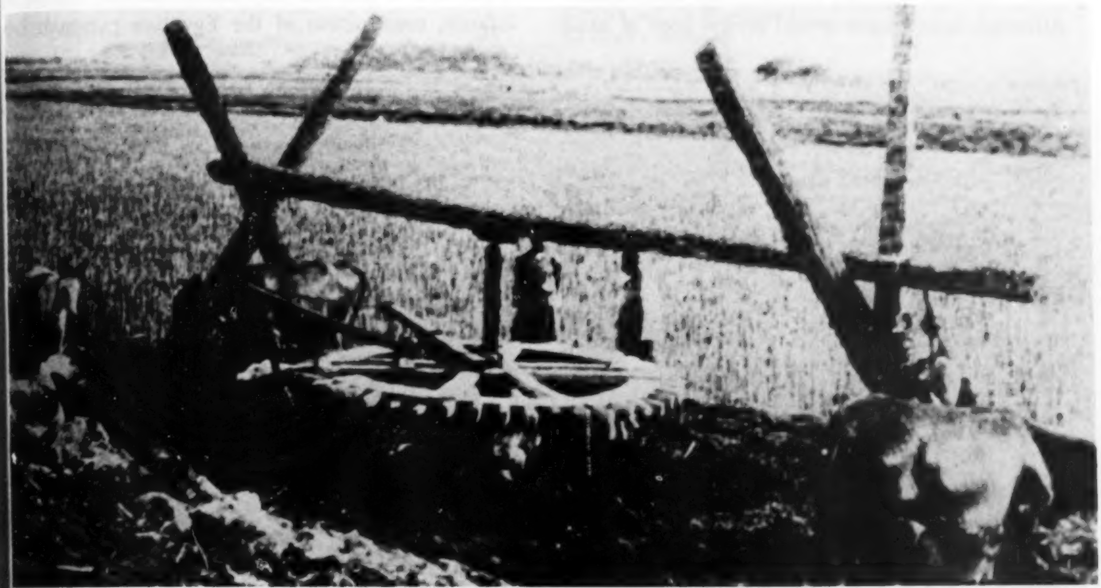
Construction of kanats is still carried on in Iran much as it was centuries ago. It is a specialized vocation, handed down from father to son through many generations. The workers, called "muqannis," are organized in guilds and highly respected—no one will say a word against them. Initial construction steps follow

This leather pumping bucket is a necessary tool for the old man's daily labors.

age-old tradition. First, a dowser or water witch selects a site for the well that is to yield water. The odds that he will succeed favor him, for the terrain at the base of a mountain is normally a catch basin for rain and snow water flowing down from higher elevations. A shaft or well is sunk at the chosen spot to a depth at which water at least 2 meters deep accumulates overnight. The chief of the diggers' guild then oversees the start of tunneling with appropriate ceremonies. Much of the muqannis' work consists of keeping the kanats open and their flow unimpeded. For this, boys are often employed because of their small size. Some begin their labors when about 8 years old.

Tradition holds that white, blind fish inhabit kanats. This belief was checked some years ago by four Oxford University students who were in Iran observing the life of the villagers. Fish were found, but they were not blind. The natives have a compunction against eating them, saying that they are "an act of Allah."

Romans adopted existing kanats in the arid countries they dominated, as evidenced by recent findings. Oliver H. Folsom, an American construction engineer employed from 1960–64 to increase Jordan's water supply, located and restored some 50 old water courses. He first looked for anything green. Even a single tuft of grass or one bush meant water was near. "Almost al-



There probably are as many different kinds of water devices as there are countries. This water wheel is found in India.

ways," Folsom reported, "when we dug in such places we found remains of old Roman works. Some had been so wrecked that we could not use them and had to build all over. But, wherever possible, we merely repaired and strengthened them."

Although Folsom did not use the word "kanat," his description indicated that some works corresponded closely to kanat construction. The builders apparently dug wells, raised water from them, and conducted it in tunnels or canals to storage reservoirs, from which it was distributed to points of use. "There is little we could have taught the Romans about the utilization of water supplies," Folsom stated. "Their basic engineering concepts equaled anything we have today."

Although kanats have almost always been of small diameter, a few were made large enough to double as escape routes should the city served be attacked. A prominent example was the tunnel that conveyed water to the island city of Samos, offshore Turkey in the Gulf of Izmir. It was built about 450 B.C. (some sources say as early as 650 B.C.), and its ruins were discovered in 1882 by the abbot of a monastery while cultivating land. The 2,800-foot tunnel was about 5 feet wide and 6 feet high and had a portal close to the coast to permit escape by boat. Construction was directed by Eupalinos, reported to have been the first civil engineer (see *Compressed Air,* July 1943, page 7086).

For this era, when engineering science was in its infancy, construction of the Egyptian pyramids ha

Another irrigation assist—a water-powered, water-lifting device.

rightfully been considered marvelous. Compared with them, creation of Iran's kanats was, in some respects, a small achievement, but there are aspects where comparison is justified. Erection of the pyramids occupied three pharaohs of the fourth Egyptian dynasty. Collectively, they drained the financial resources of Egypt as much as any war could. For what?

Pyramids had no useful purpose other than serving as memorials and mausoleums for the monarchs concerned. They are, as H. G. Wells observed, "unmeaning sepulchral piles." The pyramid of Cheops alone stands 450 feet high and has been calculated to weigh 4,885,000 tons. All of this stone was quarried and lugged into place by the muscles of 100,000 men over a period of 30 years.

Contrast this vast expenditure of human energy with the accomplishment of a relatively few individuals burrowing beneath the desert sands of Iran. It is doubtful if the creation of the estimated 100,000 miles of kanats, spread over some 25 centuries, has occupied a tenth of the manpower that went into the Cheops repository for royal bones. Though vastly dissimilar, perhaps the two undertakings do not rank too far apart as ancient engineering feats. From the standpoint of service to mankind, the kanats win hands down. They were and are the lifeblood of farms, orchards, and communities where millions live. Verily, they made the desert bloom! □

This Shauhala irrigation system is found along the Dabus River in Ethiopia.

WATER QUIZ

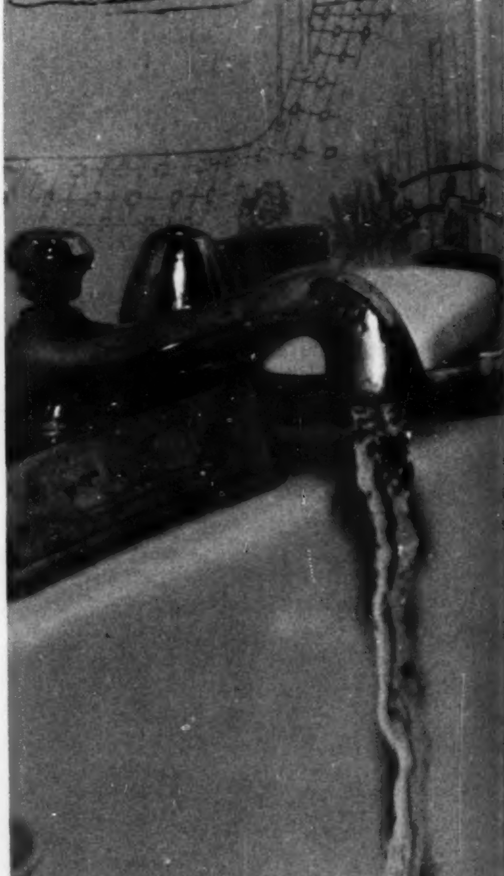
1. As we know, ice is less dense than water, but in a tank of water and melting ice, the water with the highest density is that melting directly off the ice. Why?

2. Water containing many impurities conducts electricity better than pure water. True or false? Why?

3. Water is close to being the all-purpose chemical solvent. Given enough time, it will dissolve almost any organic substance, in fact, about ____ percent of the known elements are found dissolved in the earth's waters.

4. The shape of a drop of water changes many times from faucet to sink. First, a water drop forming on the lip of a tap is given its shape by the hydrogen bonds pulling its molecules inward toward the center of the drop—one manifestation of surface tension. Second, owing to gravity, the drop initially takes a tear shape. Third, it becomes spherical as it falls. What shape does the drop take prior to hitting the sink and why?

5. Two flasks are each filled with one liter of water and weighed, and six different compounds are poured into one flask and that flask is weighed. An equal amount of the same six compounds are weighed with, but not poured into the second flask. Explain why the water and compound mixture weighs the same as the water and dry compounds, but there is *no increase in volume of the mixture.*



Answers on page 32.

news NOTES

With One Final Swoop!

With one final swoop the retirement bird plucked many supervisors from the Bureau's nest. Prompted by a 6.1% annuity increase some key Bureau personnel decided now was the time to go. Other factors undoubtedly played a part in each decision, but the net result was 435 June retirements including the following:

Harold E. Aldrich

Harold E. Aldrich, Regional Director, Upper Missouri Region, retired June 22. Mr. Aldrich had been with the Bureau of Reclamation for 32 years, starting as an engineer in the Denver office and progressing in position and responsibility until he became Regional Director at Billings, Mont. He has had a career of 38 years in water development.

Chester R. Baggs

Chester R. Baggs, Chief, Division of Personnel and Management, had been with the Bureau of Reclamation for 23 years. Baggs started as the Regional Employment and Training Officer in Sacramento, Calif. He has had 31 years of Federal service. He retired June 30.

Charles C. Butler

Charles C. Butler, Chief, Divsion of Youth Conservation Programs, retired from the Bureau on June 30. Over the past years Butler had worked to build up the Youth Conservation Corps and had encouraged many young people to engage in its activities. Butler had 31 years of Federal service, 20 of which he spent with the Bureau of Reclamation.

Edwin C. Davis

Ed Davis, Assistant Solicitor, Branch of Reclamation and Water, retired June 30. Davis is a Federal career employee of 38 years, 24 of which he spent in connection with the Bureau of Reclamation.

William H. Keating

William H. Keating, Assistant Commissioner—Resource Development, retired June 30. He had 29 years of Federal service, five in the Army during World War II, and 24 years with the Bureau of Reclamation. Keating started as an engineering aide in the North Platte River District office in Casper, Wyo.

Maurice N. Langley

Maurice N. Langley, Chief, Division of Water and Land in the Washington Office, retired June 9. He was a recognized expert in the fields of land classification and water quality. He joined the Bureau in 1946 as a soil technologist in Yuma, Ariz. In 1959 he transferred to the Washington Office in the Division of Irrigation and Land Use. In 1964 he was named Chief, Division of Irrigation and Land Use (now Division of Water and Land).

Daniel V. McCarthy

Daniel V. McCarthy, Chief, Division of Planning, had 39 years of Federal service, including 28 years with the Bureau. He was formerly with the Tennessee Valley Authority, the U.S. Army Corps of Engineers, National Resources Planning Board, and the War Production Board. He retired June 30.

T. W. Mermel

T. W. Mermel, Assistant to the Commissioner—Scientific Affairs, retired June 30. Mermel, a contributor to the *Reclamation Era,* began his career as an Engineering Draftsman at the Chief Engineer's office (now the E&R Center in Denver, Colo.) Mermel transferred to the Washington Office in 1943. Mermel had 43 years of government service, nearly 40 with the Bureau.

Robert J. Pafford

Robert J. Pafford, Regional Director, Mid-Pacific Region, Sacramento, Calif., retired June 29. Pafford began his career with the Bureau in this position in 1963, after more than 28 years with the Corps of Engineers. He has been associated with water resource development for a total of 39 years.

James E. Stokes

James E. Stokes, South Platte River Projects, Loveland, Colo., retired after serving Reclamation since 1941. Stokes served as Assistant Chief, in the Branch of Power Utilization in Denver and Washington, D.C. Stokes also served as Assistant Regional Supervisor of Power in Sacramento, Calif.

Wade H. Taylor

Wade H. Taylor, Chief, Division of Power O&M, E&R Center, Denver, retired after being with the Bureau since 1935 when he joined as a Junior Engineer at the Denver offices. In 1938, Taylor transferred to the Electrical and Mechanical Division and early in 1945, he was appointed Assistant Regional Power Supervisor in Region 3.

Kermit K. Young

Kermit K. Young, Chief, Division of General Engineering, also retired June 30. A devout behind-the-scenes contributor to the *Era,* Young had 39 years of service with the Bureau of Reclamation. He started as a civil engineer at the Chief Engineer's office in Denver, Colo.

Letters to the Editor

Dear Editor:

Please let me compliment you on *Reclamation Era,* which continues to be an attractive and readable publication that deals with some of the uses of water.

"Water Quiz" is one of the interesting sections of the publication, and the one in the Spring 1973 issue (p. 23) particularly attracted my attention.

The diagram illustrates the effect of only *packing* on porosity, using the same grain size. However, the answer (p. 29) implies that Figure A represents a sandstone and Figure B represents a clay; since the *grain size* and *sorting* are the same in both figures, and are those used in all text books and other reference works to illustrate uniformly rounded and sized sand or silt grains, this misimpression of standstone vs. clay is unfortunate. The lesser porosity of clay is due to the *shape* of the grains as well as their packing. Furthermore, Figures A and B are of an *uncemented* sandstone, for cement decreases the porosity also. As Davis and DeWiest point out (1960, p. 160, Figures 6.2 a 6.3), the factors that contribute to porosity are pa ing of the grains, their shape, arrangement, and distribution.

You might wish to apprise your readers, in c some of them may be misled.

Sincerely,
Allen F. Agnew, Dire
and Professor of Geolo
University of Washin

Dear Mr. Agnew:

Thank you for your clarification, we appreciate y taking time to enlighten us.

—Editor

Dear Editor:

I would like to congratulate you on the *Era's* n appearance, I have enjoyed it much.

I understand requests for articles are in order. If may I request an article on salmon, especially salm on the Central Valley project. I am most interested them.

Thank you,
Henry Baldford
Sacramento, Cal

Dear Mr. Baldford:

Your salmon article is in the making and shou be in the Winter 1974 issue.

—Editor

Answers to Water Quiz:

1. This brief period of great density occurs beca as ice melts, the hydrogen bonds between molecu begin to collapse and the molecules grow close togeth (At 39 degrees F., they reach maximum density.)

2. True, because pure water does not contain free charged particles needed to carry an electric c rent through a medium such as water. When impuri are added to pure water, the impurities act as the f charged particles which carry the current through water.

3. Fifty

4. The drop of water ultimately flattens out bef hitting a surface because of air resistance.

5. A solid compound dropped into liquid water quickly broken up by water molecules, which sque between the solid particles, separate them from another and surround the liberated particles wit protective shield that prevents them from regroupi This is commonly referred to as dissolving.

U.S. GOVERNMENT PRINTING OFFICE : 1973 O - 508-4

6.2 a
re pa
and s
in c
Direc
Geolo
shing
iate yo
Editor
Era's
ler. If
y salm
erested
u,
ldford
to, Ca
d shou
Editor
s beca
molecu
togeth
y.)
ntain
ctric c
mpuri
s the f
rough
ut bef
wate
n sque
from
es wit
group
508-

UNITED STATES
GOVERNMENT PRINTING OFFICE
PUBLIC DOCUMENTS DEPARTMENT
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

U.S.MAIL

WATER FOR TOMORROW

Specialists discuss problems and solutions of water conservation and development.

Subscribe now!

$2.50 per year

(75 cents additional for foreign mailing)

Read about the multipurpose uses of Reclamation's projects. Learn how Reclamation's dams, reservoirs, canals have benefitted our Nation.

The Bureau of Reclamation opens its waters to such activities as: • *Municipal and industrial uses* • *Fish and wildlife preservation* • *Natural resource conservation* • *Recreation* • *Flood control* • *Power generation*

Issued quarterly, the RECLAMATION ERA is the official publication of the Bureau of Reclamation, U.S. Department of the Interior.

SUBSCRIPTION ORDER FORM

ENTER MY SUBSCRIPTION TO *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, ______ @ $ 2.50 ______ Add $ .75 ______ for foreign mailing. No additional postage is required for mailing within the Unit[ed] States, its possessions, Canada, Mexico, and all Central and South American Countries except Argentina, Brazil, British Hondura[s], French Guiana, Guyana, and Surinam. For shipment to all other foreign countries include additional postage as quoted for ea[ch] periodical or subscription service.

Send Subscription to:

NAME – FIRST, LAST

COMPANY NAME OR ADDITIONAL ADDRESS LINE

STREET ADDRESS

CITY | STATE | ZIP CODE

PLEASE PRINT

☐ Remittance Enclosed (Ma[ke] checks payable to Superintend[ent] of Documents)

☐ Charge to my Deposit Accou[nt] No. ______

MAIL ORDER FORM TO:
Superintendent of Documents
Government Printing Offic[e]
Washington, D.C. 20402

MAIL

W

e Unite
onduras
for eac

(Mak
erintend

Accou

nents
Offic